

## **English translation of relevant portions of JP 2002-224565A**

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Translated portions are as follows:  
paragraphs [0011]-[0083] and [0089]-[0092]; Tables 1-7 and 11; and the sections of "BRIEF EXPLANATION OF DRAWINGS" and "EXPLANATION OF NUMERALS" (page 14, right column, line 45 through page 15, right column, line 9).

[0011]

[Description of the Preferred Embodiments] The decompositionally treating agent and the decompositionally treating method for fluorocarbons according to the present invention are applied to the decompositional treatment of perfluorocarbons and hydrofluorocarbons contained in gases (such as nitrogen, argon, and helium), the former derived from hydrocarbons by the replacement of all hydrogen atoms thereof with fluorine atoms and the latter derived from hydrocarbons by the replacement of some hydrogen atoms thereof with fluorine atoms. In the decompositional treatment of chemically stable  $\text{CF}_4$  among these fluorocarbons, the treating agent and method according to the present invention are particularly effective in terms of their capability of decomposing  $\text{CF}_4$  at a decomposition rate of at least 99.9 % at a decomposition temperature of 1000 °C or lower without deactivating the decompositionally treating agent in a short time and without releasing corrosive gases, such as hydrogen fluoride.

[0012] The decompositionally treating agent for fluorocarbons according to the present invention comprises, as active ingredients, aluminum oxide and an alkaline earth metal oxide, such as magnesium oxide, calcium oxide, or strontium oxide. Alternately, the agent comprises, as active ingredients, aluminum oxide and an alkaline earth metal compound that thermally decomposes into an alkaline earth metal oxide, such as calcium hydroxide, calcium carbonate, strontium hydroxide, or strontium carbonate.

[0013] The decompositionally treating method for fluorocarbons according to the present invention comprises decomposing fluorocarbons by bringing a fluorocarbon-containing gas into contact under heating with the decompositionally treating agent comprising, as active ingredients, aluminum oxide and an alkaline earth metal oxide. Alternately, the method comprises decomposing fluorocarbons by bringing a fluorocarbon-containing gas into contact, under heating in the presence of oxygen and/or steam, alternately with a treating agent comprising, as an active ingredient, aluminum oxide and a treating agent comprising, as an active ingredient, an alkaline earth metal oxide.

[0014] The decompositionally treating agent and the decompositionally treating method for fluorocarbons according to the present invention decompositionally treat fluorocarbons, for example, including perfluorocarbons, such as  $\text{CF}_4$ ,  $\text{C}_2\text{F}_6$ ,  $\text{C}_3\text{F}_8$ ,  $\text{C}_4\text{F}_{10}$ ,  $\text{C}_5\text{F}_{12}$ ,  $\text{C}_4\text{F}_8$ ,  $\text{C}_4\text{F}_6$ , and  $\text{C}_5\text{F}_8$ , and hydrofluorocarbons, such as  $\text{CH}_3\text{F}$ ,  $\text{CH}_2\text{F}_2$ ,  $\text{CHF}_3$ ,  $\text{C}_2\text{H}_4\text{F}_2$ , and  $\text{C}_2\text{H}_2\text{F}_4$ .

[0015] The following provides a detailed description of the decompositionally treating agent for fluorocarbons according to the present invention. The agent employs, as active ingredients, aluminum oxide and an alkaline earth metal oxide or an alkaline earth metal compound that thermally decomposes into an alkaline earth metal oxide. In the present invention, it is preferable to use aluminum oxide with pores of an average pore diameter of 50 to 200 Å. The use of aluminum oxide with pores of an average pore diameter smaller than 50 Å or larger than 200 Å may lower the fluorocarbon decomposition rate. Preferably, the aluminum oxide has a specific surface area of at least 100  $\text{m}^2/\text{g}$ . Preferably, the aluminum oxide has a purity of at least 99 %, more

preferably, of at least 99.9 %.

[0016] Along with aluminum oxide, the compositionally treating agent for fluorocarbons according to the present invention employs, as an active ingredient, an alkaline earth metal oxide, for example, beryllium oxide, magnesium oxide, calcium oxide, strontium oxide, or barium oxide. Since beryllium oxide has a sublimation starting temperature of 800 °C, and barium oxide raises the issue of toxicity, the use of magnesium oxide, calcium oxide, or strontium oxide is preferable.

[0017] Instead of the above-mentioned alkaline earth metal oxides, the present invention can employ an alkaline earth metal compound that decomposes into an alkaline earth metal oxide at or around the temperature at which fluorocarbons are compositionally treated. Examples of the compound include alkaline earth metal hydroxides, carbonates, sulfates, nitrates, and organic acid salts. Of these, the use of hydroxides or carbonates is preferable, because of their easy conversion into an oxide and because they emit no harmful gases. For the same reasons as the foregoing, the use of magnesium, calcium, or strontium compounds is preferable.

[0018] The compositionally treating agent for fluorocarbons according to the present invention is typically prepared by mixing and granulating the above-mentioned aluminum oxide and alkaline earth metal oxide or alkaline earth metal compound that thermally decomposes into an alkaline earth metal oxide or by separately granulating the aluminum oxide and the alkaline earth metal oxide or the alkaline earth metal compound that thermally decomposes into an alkaline earth metal oxide and then mixing the resultant granules.

[0019] In any of the above-mentioned methods for preparing the compositionally treating agent, the ratio of the number of aluminum atoms to the number of alkaline earth metal atoms contained in the agent (Al/M) is typically regulated to between 0.05 and 5.0, preferably to between 0.2 and 3.0 (where Al represents the number of aluminum atoms, and M represents the number of beryllium, magnesium, calcium, strontium, or barium atoms). In any of the above-mentioned preparation methods, the agent is prepared by granulation into the form of a sphere with a typical diameter of about 0.1 to 20 mm, preferably 1 to 10 mm, or a similar form, or a size and form equivalent thereto.

[0020] The compositionally treating agent for fluorocarbons according to the present invention may contain a binder, in addition to the active ingredients, for the purpose of enhancing the moldability and molding strength at the time of granulation. Examples of the binder include organic binders, such as polyvinyl alcohol, polyethylene glycol, polypropylene glycol, methyl cellulose, and carboxymethyl cellulose, and inorganic binders, such as silica, diatomaceous earth, sodium silicate, and sodium hydrogen sulfate. The binder, if incorporated into the agent, is added to the active ingredients and kneaded in when the agent is being prepared. The amount of the binder to be added thereto, which varies depending on the molding conditions and the like, cannot be unequivocally specified. An unreasonably small amount prevents the binder from working effectively, whereas an unreasonably large amount deteriorates the compositional treatment performance. Thus, the amount is typically 0.1 to 10 % by weight, preferably 0.5 to 5 % by weight,

based on the total weight of the decompositionally treating agent.

[0021] The decompositionally treating agent may contain an impurity or an inert substance or the like that does not exert an adverse influence on the decomposition of fluorocarbons. The agent prior to use may contain moisture, but is preferably free from moisture. Accordingly, the aluminum oxide and the alkaline earth metal compound (or oxide) are preferably mixed and granulated by means of tablet molding. If the agent contains a binder, an impurity, an inert substance, moisture, or the like, the content of the active ingredients in the agent is typically at least 70 % by weight, preferably at least 90 % by weight.

[0022] The following provides a detailed description of the decompositionally treating method for fluorocarbons according to the present invention with reference to FIGs. 1 to 3, although the present invention shall never be limited to the described decompositionally treating method. The first embodiment of the decompositionally treating method for fluorocarbons according to the present invention relates to a method for decomposing fluorocarbons that comprises bringing a fluorocarbon-containing gas into contact under heating with a decompositionally treating agent comprising, as active ingredients, aluminum oxide and an alkaline earth metal oxide. FIG. 1 is a cross sectional view showing an example of decompositionally treating apparatus for the above-mentioned method. The second embodiment of the decompositionally treating method for fluorocarbons according to the present invention relates to a method for decomposing fluorocarbons that comprises bringing a fluorocarbon-containing gas into contact, under heating in the presence of oxygen and/or steam, alternately with a treating agent comprising, as an active ingredient, aluminum oxide and a treating agent comprising, as an active ingredient, an alkaline earth metal oxide. FIG. 2 is a cross sectional view showing an example of decompositionally treating apparatus for the above-mentioned method.

[0023] The decomposition of fluorocarbons by the first embodiment of the decompositionally treating method according to the present invention typically uses the foregoing decompositionally treating agent according to the present invention. The decomposition of fluorocarbons by the second embodiment of the decompositionally treating method according to the present invention typically uses granulated aluminum oxide as the treating agent that comprises, as an active ingredient, aluminum oxide and a granulated alkaline earth metal oxide or alkaline earth metal compound that thermally decomposes into an alkaline earth metal oxide as the treating agent that comprises, as an active ingredient, an alkaline earth metal oxide. The content of the active ingredient in each treating agent is typically at least 70 % by weight, preferably at least 90 % by weight.

[0024] In the decompositionally treating method according to the second embodiment of the present invention, the aluminum oxide has pores preferably with an average pore diameter of 50 to 200 Å, a specific surface area of at least 100 m<sup>2</sup>/g, and a purity of at least 99 %. Preferably, the alkaline earth metal oxide is magnesium oxide, calcium oxide, or strontium oxide, and the alkaline earth

metal compound that thermally decomposes into an alkaline earth metal oxide is a hydroxide or carbonate of magnesium, calcium, or strontium. Each agent is typically prepared by granulation into the form of a sphere with a diameter of about 0.1 to 20 mm, preferably about 1 to 10 mm, or a similar form, or a size and form equivalent thereto.

[0025] Before the decomposition treatment of fluorocarbons by the first embodiment of the decompositionally treating method according to the present invention, the decompositionally treating apparatus is packed with the decompositionally treating agent composed of a granule 1 prepared by mixing and granulating aluminum oxide and an alkaline earth metal compound (or oxide), as illustrated in FIG. 1 (A), or with the decompositionally treating agent composed of a mixture of granulated aluminum oxide 2 and a granulated alkaline earth metal compound (or oxide) 3, as illustrated in FIG. 1 (B).

[0026] Before the decomposition treatment of fluorocarbons by the second embodiment of the decompositionally treating method according to the present invention, the decompositionally treating apparatus is packed with alternately laminated treating agents respectively composed of granulated aluminum oxide 2 and a granulated alkaline earth metal compound (or oxide) 3, as illustrated in FIG. 2. In the decomposition treatment of fluorocarbons by the second embodiment of the decompositionally treating method, the layers of the agent composed of the granulated aluminum oxide and the agent composed of the granulated alkaline earth metal compound (or oxide) typically have a thickness of 2 to 200 mm.

[0027] The decompositionally treating apparatus to be used in the present invention is typically of cylindrical form and typically has an inside diameter of 10 to 500 mm and a length of about 20 to 2000 mm. The packing length of the decompositionally treating agent in the apparatus is typically about 10 to 1000 mm, preferably about 50 to 500 mm. If the packing length of the agent is 10 mm or less, the decomposition of fluorocarbons becomes insufficient, whereas, if the length is 1000 mm or more, an unreasonably high pressure loss occurs. A heater is typically installed on the outside of the apparatus, as illustrated in FIG. 1 or FIG. 2, for temperature control using external control equipment. The temperature can also be controlled using a multi-stage heater for the decompositionally treating apparatus.

[0028] The decomposition treatment of fluorocarbons by the first embodiment of the present invention can use the decompositionally treating agent in the form of a fixed bed, a moving bed, or a fluidized bed in such a manner as the decompositionally treating apparatus illustrated in FIG. 1. It is possible to conduct the decomposition treatment of fluorocarbons continuously over a long period of time with a configuration such that, for instance, the deactivated agent is discharged at an agent discharge port placed on the lower part of the apparatus, while the fresh agent is supplied to the reaction system through an agent feed port placed on the upper part of the apparatus.

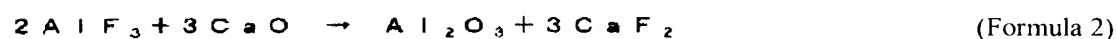
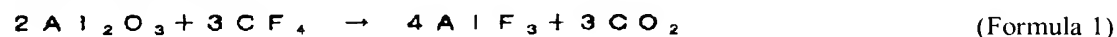
[0029] The decomposition treatment of  $\text{CF}_4$  by the first embodiment of the present invention may be conducted with the addition of an oxygen-containing gas, such as air, water, steam, or a mixture

thereof, but the addition thereof is not indispensable to the decomposition of CF<sub>4</sub> without CO emissions. Fluorocarbons other than CF<sub>4</sub> can be decomposed with the addition of nothing or water and/or steam only, but raises the issue of CO emissions. Hence, it is preferable to add an oxygen-containing gas, water, steam, or a mixture thereof in conducting decompositional treatment. The decompositional treatment of fluorocarbons by the second embodiment of the present invention is conducted with the addition of an oxygen-containing gas, water, steam, or a mixture thereof to the fluorocarbon-containing gas.

[0030] The decompositional treatment of CF<sub>4</sub> according to the present invention with the decompositional treating agent composed of aluminum oxide and calcium oxide in the absence of oxygen or steam is presumed to cause reactions represented by the following formulae 1 and 2. The decomposition of fluorocarbons other than CF<sub>4</sub>, such as C<sub>2</sub>F<sub>6</sub>, with the decompositional treating agent composed of aluminum oxide and calcium oxide in the presence of oxygen is presumed to cause reactions represented by the following formulae 3 and 4. The decomposition of C<sub>2</sub>F<sub>6</sub> with the decompositional treating agent composed of aluminum oxide and calcium oxide in the presence of steam is presumed to cause reactions represented by the following formulae 5, 6, 7, and 8.

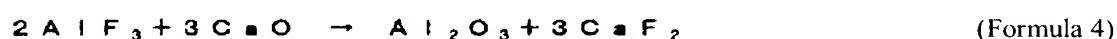
[0031]

[Chemical Formula 1]



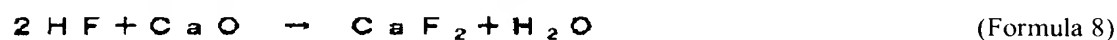
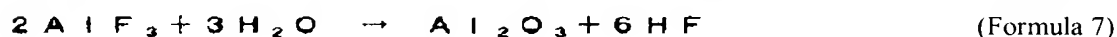
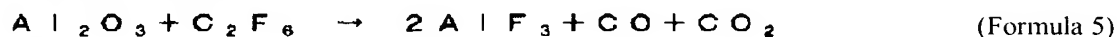
[0032]

[Chemical Formula 2]



[0033]

[Chemical Formula 3]



[0034] During the decomposition of fluorocarbons according to the present invention, the reaction with the fluorocarbons forms aluminum fluoride on the surface of aluminum oxide. The resultant aluminum fluoride immediately reacts with the alkaline earth metal oxide to regenerate aluminum oxide, thereby enabling the continuous decompositional treatment of fluorocarbons over a long period of time. CO emissions can be prevented in the presence of oxygen. The decomposition of fluorocarbons other than CF<sub>4</sub> in the absence of oxygen raises the issue of CO emissions, which can be easily removed by installing a dry cleaning apparatus in a post stage. In the presence of steam,

the steam reacts with aluminum fluoride, thus enabling decompositional treatment over a further long period of time. In this case, hydrogen fluoride is produced as a corrosive gas, but immediately disappears by reacting with the alkaline earth metal oxide, thus preventing the release of the corrosive gas from the decompositionally treating apparatus. Moreover, the decompositional treatment of fluorocarbons by the second embodiment of the present invention in the presence of steam can prevent the deactivation of aluminum oxide in the lower layer caused by HF.

[0035] The temperature of contact between fluorocarbons and the decompositionally treating agent varies depending on the fluorocarbon type, concentration, flow rate, and the like and cannot be unequivocally defined. In the case of decompositionally treating fluorocarbons other than CF<sub>4</sub>, the temperature is typically in the range of 300 to 1000 °C, and in the case of decompositionally treating CF<sub>4</sub>, the temperature is typically in the range of 700 to 1000 °C. A contact temperature equal to or lower than the above-mentioned lower limit brings about a low fluorocarbon decomposition rate, whereas a contact temperature of 1000 °C or higher has the disadvantage of requiring highly heat resistant materials for the decompositionally treating apparatus. The decompositional treatment of fluorocarbons is conducted typically under atmospheric pressure, but can also be carried out under reduced or elevated pressure.

[0036] The present invention has no specific limitation with regard to the flow velocity of the fluorocarbon-containing gas, but a decrease in the flow velocity as the fluorocarbon concentration in the gas increases is generally preferable. Thus, the decompositionally treating apparatus is designed according to the fluorocarbon type, concentration, and the like. Typically, the superficial linear velocity (LV) is at most 50 cm/sec.

[0037] FIG. 3 is a configuration diagram showing an example of a decompositionally treating system for the implementation of the decompositionally treating method for fluorocarbons according to the present invention. In the decompositionally treating system for fluorocarbons as illustrated in FIG. 3, a fluorocarbon-containing gas and oxygen and/or steam are introduced through the fluorocarbon introduction line 6 and the oxygen and/or steam introduction line 7, respectively, into the decompositionally treating apparatus for fluorocarbons 9, where the fluorocarbon is decompositionally treated. The decomposed products are discharged through the decomposed gas discharge line 11. The decompositional treatment of fluorocarbons by the first embodiment of the present invention can be conducted without the use of the oxygen and/or steam introduction line 7. Since the treating method according to the present invention emits no corrosive gas, as illustrated in FIG. 3, it is possible that a fluorocarbon-containing gas prior to the decompositional treatment and the gas after the decompositional treatment may be subject to heat exchange with each other by means of a heat exchanger. Moreover, the present invention dispenses with equipment for cleaning corrosive gases, such as hydrogen fluoride.

[0038]

[Examples] In what follows, the present invention will be described in more detail with reference to

examples, although the present invention shall never be limited to these examples.

[0039] Example 1

(Preparation of the decompositionally treating agent)

A commercially available alumina catalyst (average pore diameter of 130 Å and purity of 99.9 %) and calcium oxide (purity of 99 %) were each pulverized to 100 µm or smaller and mixed so as to achieve an atomic ratio (Al/Ca) of 0.5. The resultant mixture was packed in a mold measuring 20 mm in inside diameter and 5 mm in height. Then, the packed mixture was compressed using a hydraulic jack at a pressure of 150 to 160 kg/cm<sup>2</sup> for 30 seconds. The resulting molded product was then ground and sifted. Particles passing through an aperture of 3.36 mm and not passing through an aperture of 2.00 mm were selected for use as a decompositionally treating agent.

[0040] (Decompositional treatment test)

The above-mentioned decompositionally treating agent was packed in a decompositionally treating apparatus made of ceramic and having an inside diameter of 42 mm and a length of 1000 mm with a configuration as illustrated in FIG. 1 (A), so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing CF<sub>4</sub> at a flow rate of 10 ml/min, making a total flow rate of 877 ml/min, was introduced into the apparatus along with steam at a flow rate of 73 ml/min and oxygen at a flow rate of 50 ml/min to decompose CF<sub>4</sub>.

[0041] During the operation, part of the decomposed gas discharged through the discharge port of the apparatus was sampled and analyzed for CF<sub>4</sub> at 30 minute intervals by means of FT-IR (Fourier transform infrared spectrophotometer) and GC-TCD (thermal conductivity detector). In this way, the time required until the CF<sub>4</sub> decomposition rate became 99.9 % or less was measured and determined to be 51 hours. Thus, the decompositional treatment amount of CF<sub>4</sub> (L) per liter of the decompositionally treating agent (decompositional treatment performance) was determined. At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 1.

[0042] Examples 2 and 3

The procedure in Example 1 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for CF<sub>4</sub> using the agents thus prepared, except that, in the preparation of the agent according to Example 1, the atomic ratio of aluminum oxide to calcium oxide (Al/Ca) was altered to 0.25 and 1.0, respectively, for Examples 2 and 3. The results are given in Table 1.

[0043] Examples 4 and 5

The procedure in Example 1 was repeated to carry out the decompositional treatment tests for CF<sub>4</sub>, except that, in the decompositional treatment test according to Example 1, the CF<sub>4</sub> concentration was altered to 0.2 and 2.0 %, respectively, for Examples 4 and 5. The results are given in Table 1.

[0044] Examples 6 to 8

The procedure in Example 1 was repeated to carry out the decompositional treatment tests for



fluorocarbons, except that, in the decompositional treatment test according to Example 1,  $C_2F_6$ ,  $C_5F_8$ , and  $CHF_3$  were used as fluorocarbons in place of  $CF_4$ , respectively, for Examples 6 to 8. The results are given in Table 1.

[0045] Examples 9 to 16

The procedure in Example 1 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for  $CF_4$  using the agents thus prepared, except that, in the preparation of the agent according to Example 1, magnesium oxide (Example 9), strontium oxide (Example 10), calcium hydroxide (Example 11), magnesium hydroxide (Example 12), strontium hydroxide (Example 13), calcium carbonate (Example 14), magnesium carbonate (Example 15), and strontium carbonate (Example 16) were used in place of calcium oxide. The results are given in Table 1.

[0046] Example 17

(Preparation of the decompositionally treating agent)

A commercially available alumina catalyst (average pore diameter of 130 Å, purity of 99.9 %, and particle diameter of 2 to 3 mm) was used as granulated aluminum oxide. Commercially available calcium oxide (purity of 99 %) was pulverized to 100 µm or smaller, packed in a mold measuring 20 mm in inside diameter and 5 mm in height, and then compressed using a hydraulic jack at a pressure of 150 to 160 kg/cm<sup>2</sup> for 30 seconds. The resulting molded product was ground and sifted. Particles passing through an aperture of 3.36 mm and not passing through an aperture of 2.00 mm were selected for use as granulated calcium oxide. These granulated oxides were mixed so as to achieve an atomic ratio (Al/Ca) of 0.5. The resultant mixture was used as a decompositionally treating agent.

[0047] (Decompositional treatment test)

The above-mentioned decompositionally treating agent was packed in a decompositionally treating apparatus made of ceramic and having an inside diameter of 42 mm and a length of 1000 mm with a configuration as illustrated in FIG. 1 (B), so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing  $CF_4$  at a flow rate of 10 ml/min, making a total flow rate of 877 ml/min, was introduced into the apparatus along with steam at a flow rate of 73 ml/min and oxygen at a flow rate of 50 ml/min to decompose  $CF_4$ .

[0048] During the operation, part of the decomposed gas discharged through the discharge port of the apparatus was sampled and analyzed for  $CF_4$  at 30 minute intervals by means of FT-IR (Fourier transform infrared spectrophotometer) and GC-TCD (thermal conductivity detector). In this way, the time required until the  $CF_4$  decomposition rate became 99.9 % or less was measured to determine the decompositional treatment amount of  $CF_4$  (L) per liter of the decompositionally treating agent (decompositional treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 2.

[0049] Examples 18 and 19

The procedure in Example 17 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for  $\text{CF}_4$  using the agents thus prepared, except that, in the preparation of the decompositionally treating agent according to Example 17, the atomic ratio of granulated aluminum oxide to granulated calcium oxide (Al/Ca) was altered to 0.25 and 1.0, respectively, for Examples 18 and 19. The results are given in Table 2.

[0050] Examples 20 and 21

The procedure in Example 17 was repeated to carry out the decompositional treatment tests for  $\text{CF}_4$ , except that, in the decompositional treatment test according to Example 17, the  $\text{CF}_4$  concentration was altered to 0.2 and 2.0 %, respectively, for Examples 20 and 21. The results are given in Table 2.

[0051] Examples 22 to 24

The procedure in Example 17 was repeated to carry out the decompositional treatment tests for fluorocarbons, except that, in the decompositional treatment test according to Example 17,  $\text{C}_2\text{F}_6$ ,  $\text{C}_5\text{F}_8$ , and  $\text{CHF}_3$  were used as fluorocarbons in place of  $\text{CF}_4$ , respectively, for Examples 22 to 24. The results are given in Table 2.

[0052] Examples 25 to 32

The procedure in Example 17 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for  $\text{CF}_4$  using the agents thus prepared, except that, in the preparation of the agent according to Example 17, magnesium oxide (Example 25), strontium oxide (Example 26), calcium hydroxide (Example 27), magnesium hydroxide (Example 28), strontium hydroxide (Example 29), calcium carbonate (Example 30), magnesium carbonate (Example 31), and strontium carbonate (Example 32) were used in place of calcium oxide. The results are given in Table 2.

[0053] Example 33

(Preparation of the treating agent)

A commercially available alumina catalyst (average pore diameter of 130 Å, purity of 99.9 %, and particle diameter of 2 to 3 mm) was used as a treating agent composed of granulated aluminum oxide. Commercially available calcium oxide (purity of 99 %) was pulverized to 100  $\mu\text{m}$  or smaller, packed in a mold measuring 20 mm in inside diameter and 5 mm in height, and then compressed using a hydraulic jack at a pressure of 150 to 160  $\text{kg}/\text{cm}^2$  for 30 seconds. The resulting molded product was ground and sifted. Particles passing through an aperture of 3.36 mm and not passing through an aperture of 2.00 mm were selected for use as a treating agent composed of granulated calcium oxide.

[0054] (Decompositional treatment test)

The above-mentioned treating agents were packed in a decompositionally treating apparatus made of ceramic and having an inside diameter of 42 mm and a length of 1000 mm with a configuration as

illustrated in FIG. 2, wherein four layers of each agent were alternately laminated so as to achieve an atomic ratio (Al/Ca) of 0.5 and a total packing length of 600 mm. The agents in the apparatus were heated to 860 °C, and then nitrogen containing CF<sub>4</sub> at a flow rate of 10 ml/min, making a total flow rate of 877 ml/min, was introduced into the apparatus along with steam at a flow rate of 73 ml/min and oxygen at a flow rate of 50 ml/min to decompose CF<sub>4</sub>.

[0055] During the operation, part of the decomposed gas discharged through the discharge port of the apparatus was sampled and analyzed for CF<sub>4</sub> at 30 minute intervals by means of FT-IR (Fourier transform infrared spectrophotometer) and GC-TCD (thermal conductivity detector). In this way, the time required until the CF<sub>4</sub> decomposition rate became 99.9 % or less was measured to determine the decompositional treatment amount of CF<sub>4</sub> (L) per liter of the decompositionally treating agent (decompositional treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 3.

[0056] Examples 34 and 35

The procedure in Example 33 was repeated to carry out the decompositional treatment tests for CF<sub>4</sub>, except that, in the decompositional treatment test according to Example 33, the agents were laminated so that the atomic ratio of aluminum oxide to calcium oxide (Al/Ca) was altered to 0.25 and 1.0, respectively, for Examples 34 and 35. The results are given in Table 3.

[0057] Examples 36 and 37

The procedure in Example 33 was repeated to carry out the decompositional treatment tests for CF<sub>4</sub>, except that, in the decompositional treatment test according to Example 33, the CF<sub>4</sub> concentration was altered to 0.2 and 2.0 %, respectively, for Examples 36 and 37. The results are given in Table 3.

[0058] Examples 38 to 40

The procedure in Example 33 was repeated to carry out the decompositional treatment tests for fluorocarbons, except that, in the decompositional treatment test according to Example 33, C<sub>2</sub>F<sub>6</sub>, C<sub>5</sub>F<sub>8</sub>, and CHF<sub>3</sub> were used as fluorocarbons in place of CF<sub>4</sub>, respectively, for Examples 38 to 40. The results are given in Table 3.

[0059] Examples 41 to 48

The procedure in Example 33 was repeated to prepare the treating agents and carry out the decompositional treatment tests for CF<sub>4</sub> using the agents thus prepared, except that, in the preparation of the agents according to Example 33, magnesium oxide (Example 41), strontium oxide (Example 42), calcium hydroxide (Example 43), magnesium hydroxide (Example 44), strontium hydroxide (Example 45), calcium carbonate (Example 46), magnesium carbonate (Example 47), and strontium carbonate (Example 48) were used in place of calcium oxide. The results are given in Table 3.

[0060] Example 49

A decompositionally treating agent prepared in the same manner as in Example 1 was packed in a decompositionally treating apparatus made of SUS316L and having an inside diameter of 42 mm and a length of 1000 mm with a configuration as illustrated in FIG. 1 (A), so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing CF<sub>4</sub> at a flow rate of 10 ml/min, making a total flow rate of 1000 ml/min, was introduced into the apparatus to decompose CF<sub>4</sub>.

[0061] During the operation, part of the decomposed gas discharged through the discharge port of the apparatus was sampled and analyzed for CF<sub>4</sub> at 30 minute intervals by means of FT-IR (Fourier transform infrared spectrophotometer) and GC-TCD (thermal conductivity detector). In this way, the time required until the CF<sub>4</sub> decomposition rate became 99.9 % or less was measured to determine the decompositional treatment amount of CF<sub>4</sub> (L) per liter of the decompositionally treating agent (decompositional treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 4.

[0062] Examples 50 and 51

The procedure in Example 49 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for CF<sub>4</sub> using the agents thus prepared, except that, in the preparation of the decompositionally treating agent according to Example 49, the atomic ratio of aluminum oxide to calcium oxide (Al/Ca) was altered to 0.25 and 1.0, respectively, for Examples 50 and 51. The results are given in Table 4.

[0063] Examples 52 and 53

The procedure in Example 49 was repeated to carry out the decompositional treatment tests for CF<sub>4</sub>, except that, in the decompositional treatment test according to Example 49, the CF<sub>4</sub> concentration was altered to 0.2 and 2.0 %, respectively, for Examples 52 and 53. The results are given in Table 4.

[0064] Examples 54 to 56

The procedure in Example 49 was repeated to carry out the decompositional treatment tests for fluorocarbons, except that, in the decompositional treatment test according to Example 49, C<sub>2</sub>F<sub>6</sub>, C<sub>5</sub>F<sub>8</sub>, and CHF<sub>3</sub> were used as fluorocarbons in place of CF<sub>4</sub>, respectively, for Examples 54 to 56. The results are given in Table 4.

[0065] Examples 57 to 64

The procedure in Example 49 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for CF<sub>4</sub> using the agents thus prepared, except that, in the preparation of the agent according to Example 49, magnesium oxide (Example 57), strontium oxide (Example 58), calcium hydroxide (Example 59), magnesium hydroxide (Example 60), strontium hydroxide (Example 61), calcium carbonate (Example 62), magnesium carbonate (Example 63), and strontium carbonate (Example 64) were used in place of calcium oxide. The

results are given in Table 4.

[0066] Example 65

A decompositionally treating agent prepared in the same manner as in Example 17 was packed in a decompositionally treating apparatus made of SUS316L and having an inside diameter of 42 mm and a length of 1000 mm with a configuration as illustrated in FIG. 1 (B), so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing CF<sub>4</sub> at a flow rate of 10 ml/min, making a total flow rate of 1000 ml/min, was introduced into the apparatus to decompose CF<sub>4</sub>.

[0067] During the operation, part of the decomposed gas discharged through the discharge port of the apparatus was sampled and analyzed for CF<sub>4</sub> at 30 minute intervals by means of FT-IR (Fourier transform infrared spectrophotometer) and GC-TCD (thermal conductivity detector). In this way, the time required until the CF<sub>4</sub> decomposition rate became 99.9 % or less was measured to determine the decompositional treatment amount of CF<sub>4</sub> (L) per liter of the decompositionally treating agent (decompositional treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 5.

[0068] Examples 66 and 67

The procedure in Example 65 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for CF<sub>4</sub> using the agents thus prepared, except that, in the preparation of the decompositionally treating agent according to Example 65, the atomic ratio of granulated aluminum oxide to granulated calcium oxide (Al/Ca) was altered to 0.25 and 1.0, respectively, for Examples 66 and 67. The results are given in Table 5.

[0069] Examples 68 and 69

The procedure in Example 65 was repeated to carry out the decompositional treatment tests for CF<sub>4</sub>, except that, in the decompositional treatment test according to Example 65, the CF<sub>4</sub> concentration was altered to 0.2 and 2.0 %, respectively, for Examples 68 and 69. The results are given in Table 5.

[0070] Examples 70 to 72

The procedure in Example 65 was repeated to carry out the decompositional treatment tests for fluorocarbons, except that, in the decompositional treatment test according to Example 65, C<sub>2</sub>F<sub>6</sub>, C<sub>5</sub>F<sub>8</sub>, and CHF<sub>3</sub> were used as fluorocarbons in place of CF<sub>4</sub>, respectively, for Examples 70 to 72. The results are given in Table 5.

[0071] Examples 73 to 80

The procedure in Example 65 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for CF<sub>4</sub> using the agents thus prepared, except that, in the preparation of the agent according to Example 65, magnesium oxide (Example 73), strontium oxide (Example 74), calcium hydroxide (Example 75), magnesium hydroxide (Example 76),

strontium hydroxide (Example 77), calcium carbonate (Example 78), magnesium carbonate (Example 79), and strontium carbonate (Example 80) were used in place of calcium oxide. The results are given in Table 5.

[0072] Example 81

(Preparation of the decompositionally treating agent)

A decompositionally treating agent prepared in the same manner as in Example 1 was packed in a decompositionally treating apparatus made of SUS316L and having an inside diameter of 42 mm and a length of 1000 mm with a configuration as illustrated in FIG. 1 (A), so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing CF<sub>4</sub> at a flow rate of 10 ml/min, making a total flow rate of 950 ml/min, was introduced into the apparatus along with oxygen at a flow rate of 50 ml/min to decompose CF<sub>4</sub>.

[0073] During the operation, part of the decomposed gas discharged through the discharge port of the apparatus was sampled and analyzed for CF<sub>4</sub> at 30 minute intervals by means of FT-IR (Fourier transform infrared spectrophotometer) and GC-TCD (thermal conductivity detector). In this way, the time required until the CF<sub>4</sub> decomposition rate became 99.9 % or less was measured to determine the decompositional treatment amount of CF<sub>4</sub> (L) per liter of the decompositionally treating agent (decompositional treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 6.

[0074] Examples 82 and 83

The procedure in Example 81 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for CF<sub>4</sub> using the agents thus prepared, except that, in the preparation of the decompositionally treating agent according to Example 81, the atomic ratio of aluminum oxide to calcium oxide (Al/Ca) was altered to 0.25 and 1.0, respectively, for Examples 82 and 83. The results are given in Table 6.

[0075] Examples 84 and 85

The procedure in Example 81 was repeated to carry out the decompositional treatment tests for CF<sub>4</sub>, except that, in the decompositional treatment test according to Example 81, the CF<sub>4</sub> concentration was altered to 0.2 and 2.0 %, respectively, for Examples 84 and 85. The results are given in Table 6.

[0076] Examples 86 to 88

The procedure in Example 81 was repeated to carry out the decompositional treatment tests for fluorocarbons, except that, in the decompositional treatment test according to Example 81, C<sub>2</sub>F<sub>6</sub>, C<sub>5</sub>F<sub>8</sub>, and CHF<sub>3</sub> were used as fluorocarbons in place of CF<sub>4</sub>, respectively, for Examples 86 to 88. The results are given in Table 6.

[0077] Examples 89 to 96

The procedure in Example 81 was repeated to prepare the decompositionally treating agents and

carry out the decompositional treatment tests for  $\text{CF}_4$  using the agents thus prepared, except that, in the preparation of the agent according to Example 81, magnesium oxide (Example 89), strontium oxide (Example 90), calcium hydroxide (Example 91), magnesium hydroxide (Example 92), strontium hydroxide (Example 93), calcium carbonate (Example 94), magnesium carbonate (Example 95), and strontium carbonate (Example 96) were used in place of calcium oxide. The results are given in Table 6.

[0078] Example 97

A decompositionally treating agent prepared in the same manner as in Example 17 was packed in a decompositionally treating apparatus made of SUS316L and having an inside diameter of 42 mm and a length of 1000 mm with a configuration as illustrated in FIG. 1 (B), so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing  $\text{CF}_4$  at a flow rate of 10 ml/min, making a total flow rate of 950 ml/min, was introduced into the apparatus along with oxygen at a flow rate of 50 ml/min to decompose  $\text{CF}_4$ .

[0079] During the operation, part of the decomposed gas discharged through the discharge port of the apparatus was sampled and analyzed for  $\text{CF}_4$  at 30 minute intervals by means of FT-IR (Fourier transform infrared spectrophotometer) and GC-TCD (thermal conductivity detector). In this way, the time required until the  $\text{CF}_4$  decomposition rate became 99.9 % or less was measured to determine the decompositional treatment amount of  $\text{CF}_4$  (L) per liter of the decompositionally treating agent (decompositional treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 7.

[0080] Examples 98 and 99

The procedure in Example 97 was repeated to prepare the decompositionally treating agents and carry out the decompositional treatment tests for  $\text{CF}_4$  using the agents thus prepared, except that, in the preparation of the decompositionally treating agent according to Example 97, the atomic ratio of granulated aluminum oxide to granulated calcium oxide (Al/Ca) was altered to 0.25 and 1.0, respectively, for Examples 98 and 99. The results are given in Table 7.

[0081] Examples 100 and 101

The procedure in Example 97 was repeated to carry out the decompositional treatment tests for  $\text{CF}_4$ , except that, in the decompositional treatment test according to Example 97, the  $\text{CF}_4$  concentration was altered to 0.2 and 2.0 %, respectively, for Examples 100 and 101. The results are given in Table 7.

[0082] Examples 102 to 104

The procedure in Example 97 was repeated to carry out the decompositional treatment tests for fluorocarbons, except that, in the decompositional treatment test according to Example 97,  $\text{C}_2\text{F}_6$ ,  $\text{C}_5\text{F}_8$ , and  $\text{CHF}_3$  were used as fluorocarbons in place of  $\text{CF}_4$ , respectively, for Examples 102 to 104. The results are given in Table 7.

[0083] Examples 105 to 112

The procedure in Example 97 was repeated to prepare the decompositionally treating agents and carry out the decomposition treatment tests for  $\text{CF}_4$  using the agents thus prepared, except that, in the preparation of the agent according to Example 97, magnesium oxide (Example 105), strontium oxide (Example 106), calcium hydroxide (Example 107), magnesium hydroxide (Example 108), strontium hydroxide (Example 109), calcium carbonate (Example 110), magnesium carbonate (Example 111), and strontium carbonate (Example 112) were used in place of calcium oxide. The results are given in Table 7.

[0089] Comparative Example 1

A commercially available alumina catalyst (average pore diameter of 130 Å, purity of 99.9 %, and particle diameter of 2 to 3 mm) was used as a decompositionally treating agent composed of granulated aluminum oxide. The agent was packed in a decompositionally treating apparatus made of ceramic and having an inside diameter of 42 mm and a length of 1000 mm, so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing  $\text{CF}_4$  at a flow rate of 10 ml/min, making a total flow rate of 950 ml/min, was introduced into the apparatus along with oxygen at a flow rate of 50 ml/min to decompose  $\text{CF}_4$ .

[0090] In the same manner as in Example 1 during the operation, the time required until the  $\text{CF}_4$  decomposition rate became 99.9 % or less was measured to determine the decomposition treatment amount of  $\text{CF}_4$  (L) per liter of the decompositionally treating agent (decomposition treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 11.

[0091] Comparative Example 2

A commercially available alumina catalyst (average pore diameter of 130 Å, purity of 99.9 %, and particle diameter of 2 to 3 mm) was used as a decompositionally treating agent composed of granulated aluminum oxide. The agent was packed in a decompositionally treating apparatus made of ceramic and having an inside diameter of 42 mm and a length of 1000 mm, so as to achieve a packing length of 300 mm. The agent in the apparatus was heated to 860 °C, and then nitrogen containing  $\text{CF}_4$  at a flow rate of 10 ml/min, making a total flow rate of 877 ml/min, was introduced into the apparatus along with steam at a flow rate of 73 ml/min and oxygen at a flow rate of 50 ml/min to decompose  $\text{CF}_4$ .

[0092] In the same manner as in Example 1 during the operation, the time required until the  $\text{CF}_4$  decomposition rate became 99.9 % or less was measured to determine the decomposition treatment amount of  $\text{CF}_4$  (L) per liter of the decompositionally treating agent (decomposition treatment performance). At the same time, the existence of HF in the exhaust gas was examined using a detector (manufactured by Gastec Corporation). The results are given in Table 11.



[0093]

[TABLE 1]

	Decompositionally treating agent (AL/M) (each mixture granulated)	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Example 1	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	75	None
Example 2	Al <sub>2</sub> O <sub>3</sub> , CaO (0.25)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	38	None
Example 3	Al <sub>2</sub> O <sub>3</sub> , CaO (1.0)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	35	None
Example 4	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	0.2	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	74	None
Example 5	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	2.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	74	None
Example 6	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>2</sub> F <sub>6</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	50	None
Example 7	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>3</sub> F <sub>8</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	38	None
Example 8	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CHF <sub>3</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	98	None
Example 9	Al <sub>2</sub> O <sub>3</sub> , MgO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	75	None
Example 10	Al <sub>2</sub> O <sub>3</sub> , SrO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	42	None
Example 11	Al <sub>2</sub> O <sub>3</sub> , Ca(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	56	None
Example 12	Al <sub>2</sub> O <sub>3</sub> , Mg(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	72	None
Example 13	Al <sub>2</sub> O <sub>3</sub> , Sr(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	35	None
Example 14	Al <sub>2</sub> O <sub>3</sub> , CaCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	40	None
Example 15	Al <sub>2</sub> O <sub>3</sub> , MgCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	48	None
Example 16	Al <sub>2</sub> O <sub>3</sub> , SrCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	31	None

[0094]

[TABLE 2]

	Decompositionally treating agent (AL/M) (granules mixed)	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Example 17	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	74	None
Example 18	Al <sub>2</sub> O <sub>3</sub> , CaO (0.25)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	37	None
Example 19	Al <sub>2</sub> O <sub>3</sub> , CaO (1.0)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	36	None
Example 20	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	0.2	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	75	None
Example 21	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	2.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	73	None
Example 22	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>2</sub> F <sub>6</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	49	None
Example 23	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>3</sub> F <sub>8</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	37	None
Example 24	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CHF <sub>3</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	99	None
Example 25	Al <sub>2</sub> O <sub>3</sub> , MgO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	74	None
Example 26	Al <sub>2</sub> O <sub>3</sub> , SrO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	40	None
Example 27	Al <sub>2</sub> O <sub>3</sub> , Ca(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	56	None
Example 28	Al <sub>2</sub> O <sub>3</sub> , Mg(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	71	None
Example 29	Al <sub>2</sub> O <sub>3</sub> , Sr(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	34	None
Example 30	Al <sub>2</sub> O <sub>3</sub> , CaCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	41	None
Example 31	Al <sub>2</sub> O <sub>3</sub> , MgCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	48	None
Example 32	Al <sub>2</sub> O <sub>3</sub> , SrCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	30	None

[0095]

[TABLE 3]

	Treating agent (AL/M) (granules laminated)	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Example 33	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	91	None
Example 34	Al <sub>2</sub> O <sub>3</sub> , CaO (0.25)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	62	None
Example 35	Al <sub>2</sub> O <sub>3</sub> , CaO (1.0)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	63	None
Example 36	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	0.2	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	91	None
Example 37	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	2.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	92	None
Example 38	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>2</sub> F <sub>6</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	61	None
Example 39	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>3</sub> F <sub>8</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	45	None
Example 40	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CHF <sub>3</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	122	None
Example 41	Al <sub>2</sub> O <sub>3</sub> , MgO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	93	None
Example 42	Al <sub>2</sub> O <sub>3</sub> , SrO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	50	None
Example 43	Al <sub>2</sub> O <sub>3</sub> , Ca(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	69	None
Example 44	Al <sub>2</sub> O <sub>3</sub> , Mg(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	88	None
Example 45	Al <sub>2</sub> O <sub>3</sub> , Sr(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	42	None
Example 46	Al <sub>2</sub> O <sub>3</sub> , CaCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	51	None
Example 47	Al <sub>2</sub> O <sub>3</sub> , MgCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	60	None
Example 48	Al <sub>2</sub> O <sub>3</sub> , SrCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	35	None

[0096]

[TABLE 4]

	Decompositionally treating agent (AL/M) (each mixture granulated)	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Example 49	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	52	None
Example 50	Al <sub>2</sub> O <sub>3</sub> , CaO (0.25)	CF <sub>4</sub>	1.0	-	860	99.9	26	None
Example 51	Al <sub>2</sub> O <sub>3</sub> , CaO (1.0)	CF <sub>4</sub>	1.0	-	860	99.9	24	None
Example 52	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	0.2	-	860	99.9	51	None
Example 53	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	2.0	-	860	99.9	51	None
Example 54	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>2</sub> F <sub>6</sub>	1.0	-	860	99.9	35	None
Example 55	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>3</sub> F <sub>8</sub>	1.0	-	860	99.9	26	None
Example 56	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CHF <sub>3</sub>	1.0	-	860	99.9	68	None
Example 57	Al <sub>2</sub> O <sub>3</sub> , MgO (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	52	None
Example 58	Al <sub>2</sub> O <sub>3</sub> , SrO (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	29	None
Example 59	Al <sub>2</sub> O <sub>3</sub> , Ca(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	38	None
Example 60	Al <sub>2</sub> O <sub>3</sub> , Mg(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	49	None
Example 61	Al <sub>2</sub> O <sub>3</sub> , Sr(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	24	None
Example 62	Al <sub>2</sub> O <sub>3</sub> , CaCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	27	None
Example 63	Al <sub>2</sub> O <sub>3</sub> , MgCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	33	None
Example 64	Al <sub>2</sub> O <sub>3</sub> , SrCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	22	None

[0097]

[TABLE 5]

	Decompositionally treating agent (AL/M) (granules mixed)	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Example 65	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	36	None
Example 66	Al <sub>2</sub> O <sub>3</sub> , CaO (0.25)	CF <sub>4</sub>	1.0	-	860	99.9	19	None
Example 67	Al <sub>2</sub> O <sub>3</sub> , CaO (1.0)	CF <sub>4</sub>	1.0	-	860	99.9	18	None
Example 68	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	0.2	-	860	99.9	36	None
Example 69	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	2.0	-	860	99.9	36	None
Example 70	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>2</sub> F <sub>6</sub>	1.0	-	860	99.9	24	None
Example 71	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>3</sub> F <sub>8</sub>	1.0	-	860	99.9	18	None
Example 72	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CHF <sub>3</sub>	1.0	-	860	99.9	49	None
Example 73	Al <sub>2</sub> O <sub>3</sub> , MgO (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	36	None
Example 74	Al <sub>2</sub> O <sub>3</sub> , SrO (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	20	None
Example 75	Al <sub>2</sub> O <sub>3</sub> , Ca(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	27	None
Example 76	Al <sub>2</sub> O <sub>3</sub> , Mg(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	35	None
Example 77	Al <sub>2</sub> O <sub>3</sub> , Sr(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	17	None
Example 78	Al <sub>2</sub> O <sub>3</sub> , CaCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	20	None
Example 79	Al <sub>2</sub> O <sub>3</sub> , MgCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	23	None
Example 80	Al <sub>2</sub> O <sub>3</sub> , SrCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	-	860	99.9	15	None

[0098]

[TABLE 6]

	Decompositionally treating agent (AL/M) (each mixture granulated)	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Example 81	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	52	None
Example 82	Al <sub>2</sub> O <sub>3</sub> , CaO (0.25)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	26	None
Example 83	Al <sub>2</sub> O <sub>3</sub> , CaO (1.0)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	25	None
Example 84	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	0.2	O <sub>2</sub>	860	99.9	51	None
Example 85	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	2.0	O <sub>2</sub>	860	99.9	51	None
Example 86	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>2</sub> F <sub>6</sub>	1.0	O <sub>2</sub>	860	99.9	36	None
Example 87	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>3</sub> F <sub>8</sub>	1.0	O <sub>2</sub>	860	99.9	26	None
Example 88	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CHF <sub>3</sub>	1.0	O <sub>2</sub>	860	99.9	69	None
Example 89	Al <sub>2</sub> O <sub>3</sub> , MgO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	52	None
Example 90	Al <sub>2</sub> O <sub>3</sub> , SrO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	30	None
Example 91	Al <sub>2</sub> O <sub>3</sub> , Ca(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	38	None
Example 92	Al <sub>2</sub> O <sub>3</sub> , Mg(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	49	None
Example 93	Al <sub>2</sub> O <sub>3</sub> , Sr(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	24	None
Example 94	Al <sub>2</sub> O <sub>3</sub> , CaCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	28	None
Example 95	Al <sub>2</sub> O <sub>3</sub> , MgCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	33	None
Example 96	Al <sub>2</sub> O <sub>3</sub> , SrCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	22	None

[0099]

[TABLE 7]

	Decompositionally treating agent (AL/M) (granules mixed)	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Example 97	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	36	None
Example 98	Al <sub>2</sub> O <sub>3</sub> , CaO (0.25)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	20	None
Example 99	Al <sub>2</sub> O <sub>3</sub> , CaO (1.0)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	18	None
Example 100	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	0.2	O <sub>2</sub>	860	99.9	36	None
Example 101	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CF <sub>4</sub>	2.0	O <sub>2</sub>	860	99.9	35	None
Example 102	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>2</sub> F <sub>6</sub>	1.0	O <sub>2</sub>	860	99.9	25	None
Example 103	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	C <sub>3</sub> F <sub>8</sub>	1.0	O <sub>2</sub>	860	99.9	18	None
Example 104	Al <sub>2</sub> O <sub>3</sub> , CaO (0.5)	CHF <sub>3</sub>	1.0	O <sub>2</sub>	860	99.9	50	None
Example 105	Al <sub>2</sub> O <sub>3</sub> , MgO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	36	None
Example 106	Al <sub>2</sub> O <sub>3</sub> , SrO (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	20	None
Example 107	Al <sub>2</sub> O <sub>3</sub> , Ca(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	28	None
Example 108	Al <sub>2</sub> O <sub>3</sub> , Mg(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	35	None
Example 109	Al <sub>2</sub> O <sub>3</sub> , Sr(OH) <sub>2</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	18	None
Example 110	Al <sub>2</sub> O <sub>3</sub> , CaCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	20	None
Example 111	Al <sub>2</sub> O <sub>3</sub> , MgCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	24	None
Example 112	Al <sub>2</sub> O <sub>3</sub> , SrCO <sub>3</sub> (0.5)	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	15	None

[0103]

[TABLE 11]

	Decompositionally treating agent	Fluorocarbon	Concentration (%)	Coexisting gas	Decompositional treatment temperature	Decomposition rate (%)	Decompositional treatment performance	Release of HF
Comparable Example 1	Al <sub>2</sub> O <sub>3</sub>	CF <sub>4</sub>	1.0	O <sub>2</sub>	860	99.9	8	None
Comparable Example 2	Al <sub>2</sub> O <sub>3</sub>	CF <sub>4</sub>	1.0	O <sub>2</sub> , H <sub>2</sub> O	860	99.9	78	Present

[BRIEF EXPLANATION OF DRAWINGS]

FIG. 1 is a cross sectional view showing an example of the decompositionally treating apparatus for the implementation of the decompositionally treating method for fluorocarbons according to the present invention.

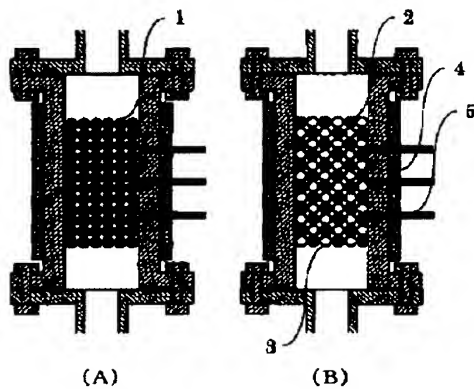
FIG. 2 is a cross sectional view showing an example of the decompositionally treating apparatus for the implementation of the decompositionally treating method for fluorocarbons according to the present invention, other than that shown in FIG. 1.

FIG. 3 is a configuration diagram showing an example of the decompositionally treating system for the implementation of the decompositionally treating method for fluorocarbons according to the present invention.

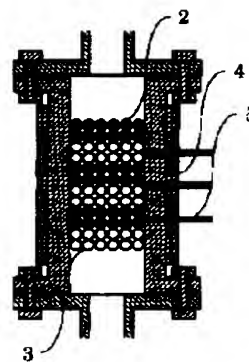
[Explanation of the Numerals]

- 1 Granule formed by mixing and granulating aluminum oxide and an alkaline earth metal compound (or oxide)
- 2 Granulated aluminum oxide
- 3 Granulated alkaline earth metal compound (or oxide)
- 4 Heater
- 5 Temperature sensor
- 6 Fluorocarbon introduction line
- 7 Oxygen and/or steam introduction line
- 8 Heat exchanger
- 9 Decompositionally treating apparatus for fluorocarbons
- 10 Temperature controller
- 11 Decomposed gas discharge line
- 12 Cooler
- 13 Blower

[FIG. 1]



[FIG. 2]



[FIG. 3]

